Ref No: **Ex/EE/PC/B/T/211/2023(S)**

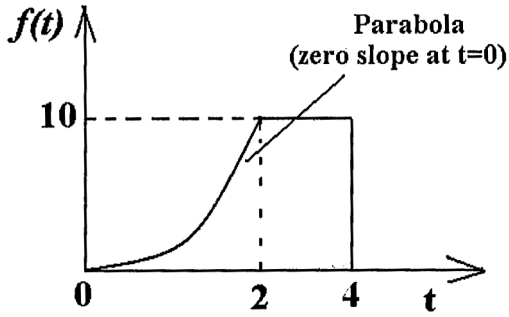
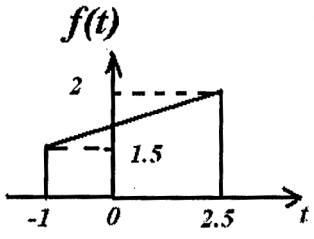
BE ELECTRICAL ENGINEERING SECOND YEAR SECOND SEMESTER SUPPLEMENTARY EXAMINATION 2023

SIGNALS AND SYSTEMS

Full Marks 100

Time: **Three hours** **(50 marks for each part)**

Use a separate Answer-Script for each part

No. of Questions	PART I	Marks
	Answer any THREE questions ***Two marks reserved for neat and well organized answers***	
1. (a)	**Define "duty cycle" and "AC-coupled crest factor" of periodic train of rectangular pulses. Derive the relation between the two.**	**8**
(b)	**Express the signal *f(t)* shown in Fig. [A] in terms of singularity functions. Also sketch its derivative.**	**8**
	 **Fig. [A]**	
2 (a)	**Consider the signal *f(t)* shown in Fig. [B].**	**6**
	 **Fig. [B]**	
	Sketch the signals $3f(t/2)$, $f(3t)$ and $f(2t-2)$.	

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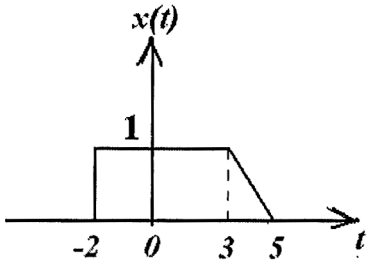
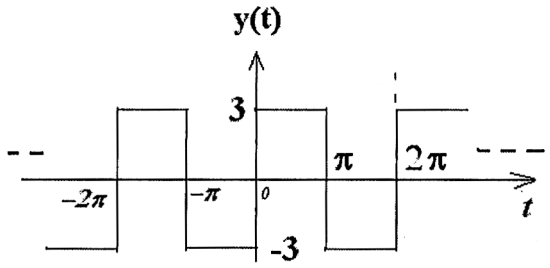
No. of Questions	PART I	Marks
(b)	**Decompose *x(t)* shown in Fig. [C] into odd and even components.**  **Fig. [C]**	**10**
3 . (a)	**Derive expressions for the exponential and the trigonometric Fourier series of the periodic signal *y*(t) shown in Fig. [D]. Also determine and sketch the one-sided amplitude spectrum and one-sided phase spectrum upto 5th harmonic.**  **Fig. [D]**	**10**
(b)	**Determine the expression for the Fourier transform, the amplitude spectrum function and the phase spectrum function of the signal** $x(t) = e^{-\alpha\|t\|}\ sgn(t)\ ;\ \alpha > 0.$	**6**
4(a)	**Examine whether the following is a power signal or energy signal or neither of them.** $\phi(t) = 3r(t) - 3r(t-5) - 15u(t-5)$	**6**

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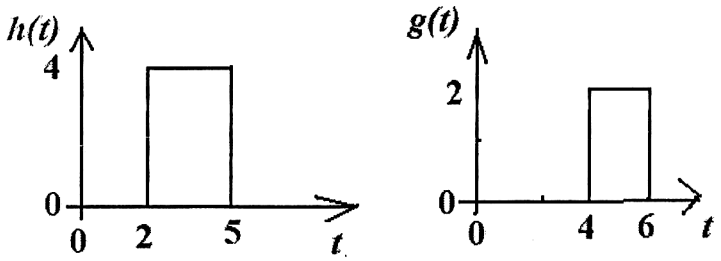
No. of Questions	PART I	Marks
(b)	**Convolve the signals *h(t)* and *g(t)* depicted in Fig.[E], graphically, and sketch the result of the convolution.**  **Fig. [E]**	**10**
5.	**Write short notes on *any two* of the following.**	
(a)	**Impulse function and its properties**	**8+8**
(b)	**Fourier transforms of unit dc, signum function and unit step.**	
(c)	**Properties of convolution and interconnection of linear time-invariant systems.**	

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B. E. ELECTRICALENGINEERING 2ND YEAR 2ND SEMESTER

SUPPLEMENTARY EXAMINATION, 2023

Subject: SIGNAL & SYSTEMS Time: Three Hours Full Marks: 100

Part II (50 marks)

Question 1 is compulsory

Answer ***Any Two*** questions from the rest (2×20)

Question No.			Marks
Q1	Answer ***Any Two*** of the following:		
	(a)	Solve the following differential equation using the Laplace Transform method $\dot{y}(t) + 2y(t) = 2x(t)$, with, $x(t) = u(t), y(0) = -1$.	5
	(b)	Determine whether the system characterized by the differential equation $\ddot{y}(t) - \dot{y}(t) + 2y(t) = x(t)$is stable or not? Assume zero initial conditions.	5
	(c)	The unit impulse response of an LTI system is the unit step function $u(t)$. Find the response of the system to an excitation $e^{-at}u(t)$.	5
	(d)	Determine the analog diagram to implement the following differential equation $\dot{x}(t) + 0.1x(t) = 1,\ x(0) = 0$.	5
Q2	(a)	Define damping ratio (ξ) and undamped natural frequency (ω_n) for a second order system? Show the location of the poles, in the s-plane, of a second order system under the following conditions: (i) critically damped and (ii) undamped.	4+4
	(b)	Obtain the transfer function, $Y(s)/X(s)$, for the circuit shown in Fig. Q2(b). Find the values of ξ and ω_n for C_1=C_2=100μF, R_1=R_2 =2000Ω.	8+4

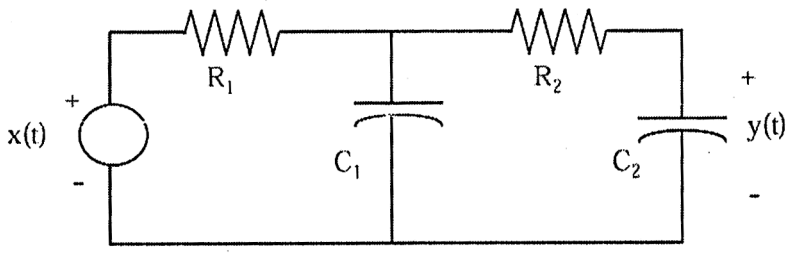

Figure Q2(b)

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Q3 (a) (i) Draw analog simulation diagram for the following system, and, (ii) obtain magnitude-scaled analog simulation of the system to utilize the full amplifier range of 0 to 10 volts without any overloading. 4+8

$$\ddot{x} + 2\dot{x} + 25x = 0, \qquad x(0) = 20, \qquad \dot{x}(0) = 0,$$
$$\text{with, } |x|_{max} = 20, \ |\dot{x}|_{max} = 100.$$

(b) For an R-L-C series circuit driven by a constant voltage source obtain a state-space model. Assume the voltage across the capacitor to be the output. 8

Q4 (a) Define state equation and output equation of an LTI system. 4+8

Consider an LTI system given by the transfer function:

$$G(s) = \frac{10s + 10}{s^3 + 6s^2 + 5s + 10}$$

Obtain the state-space model of the following system in the phase variable canonical form.

(b) (i) Write the differential equation governing the dynamic behaviour of the mechanical system, as shown in Figure Q4(b), and derive the transfer function of the system. 4+4

(ii) Derive the analogous electrical network based on *force-voltage* analogy.

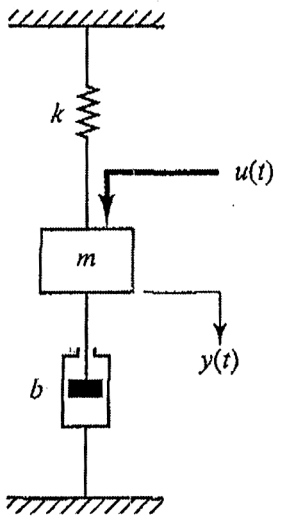

Figure Q4(b)

Q5 Write short notes on ***Any Two*** of the following:

(a) Analogy between mechanical (m-k-b) and electrical (R-L-C) systems 10

(b) Time response of undamped and critically damped second order systems 10

(c) Initial and Final Value Theorem of Laplace Transformation 10

(d) Modeling of an armature controlled d.c. motor driving a load with viscous friction. 10